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April 11, 2011

Ms. Mary Wesling
EPCRA/RMP Enforcement Coordinator
US EPA Region IX (SFD-9-3)
75 Hawthorne Street
San Francisco, CA 94105

Dear Ms. Wesling,

On March 3 I received an email from you requesting that I perform the following services:

Evaluate accuracy of four documents with regards to potential damage caused from a worst-case chemical release of butane and/or propane from the Rancho LPG Holdings LLC, (Parent Company: Plains LPG, Inc and Plains All American, Inc.) San Pedro, California Terminal, located at 2110 North Gaffey Street, San Pedro, CA. Prepare a report detailing your analysis of the risk analyses detailed in the following documents. Please provide your expert opinion on the validity of conclusions in each report.

The documents include:

1) "Quantitative Risk Analysis for Amerigas Terminal; prepared in consideration of Amerigas Propane L.P.; 2110 North Gaffey Street, San Pedro, CA 90731" dated September 2010, by Cornerstone Technologies, Inc. Long Beach, CA. (35 pp)
[Note: the facility was purchased 3 years ago by Plains LPG, Inc. and has not operated under the Amerigas name since purchase.]

2) Letter Report, dated 9/21/10, Quest Consultants, Inc. to Tony Puckett, Plains All American, Re: Butane Depot Consequence Analysis (12 pp)

3) Letter, dated 10/27/10, Rancho LPG Holding LLC to Mr. John Greenwood, Chair Planning and Land Use Committee, San Pedro CA, Re: Cornerstone Technologies, Inc.'s *Quantitative Risk Analysis for Amerigas Butane Storage Facility, dated September, 2010. (3 pp)*

4) Letter Report, dated 10/27/10, Quest Consultants, Inc. to Ronald Conrow, Rancho LPG Holdings, LLC, Re: Review of Cornerstone Report, QCI Project 6774. (13 pages)

During this evaluation I did not receive any additional information beyond what was provided in the reports, not did I have any contact with any of the principals involved.

For full disclosure, I have heard of Quest Consultants in the past. I believe they presented papers at the AICHE Global Congress on Process Safety in the past, which I attend. They also

published a paper in *Process Safety Progress* in 2009 – I was co-editor of that journal at that time but I cannot recall if I was assigned this paper. I do not recall ever meeting or talking with any of the Quest folks, but this might have occurred casually during the Global Congress. I have never had a business relationship with Quest, or any meaningful contact with any of their employees, that I can recall.

I have never heard of Cornerstone Technologies, nor am I aware of having any contact or relationship of any kind with any of the principals involved.

I do not have any financial interest or any past or present relationship with Rancho LPG Holdings LLC, or its parent company Plains LPG, Inc and Plains All American, Inc.

The North Gaffey Street facility has two very large storage tanks containing liquid butane.

This facility has several design features that dramatically impact the quantitative risk analysis (QRA) for this facility. These features reduce the consequences of an accident and thus reduce the risk. Thus, any QRA procedure that ignores these features will not have a meaningful result and will very likely dramatically overestimate the consequences and risk.

These design features are:

1. The butane is stored in refrigerated storage vessels at a temperature of 28°F, below the normal (1 atm) boiling point of 31.1°F.
2. A remote impoundment area exists a short distance from the storage vessels to collect and contain any liquid that is discharged during an emergency situation.
3. The storage vessels are insulated, low pressure, vertical storage vessels.

I will discuss these features in more detail so that the reader can understand how these design features impact the QRA.

Butane at room temperature and pressure is a gas. It is liquefied to decrease the volume in order to make it easier to store and ship. There are two approaches to storing butane as a liquid.

In the first approach (pressure case), the butane is stored in a high pressure vessel which exerts adequate pressure on the butane to maintain it in liquid form at room temperature. In this case, to store liquid butane at a temperature of 77°F requires a pressure equal to its vapor pressure at this temperature, which is 35.2 psia (20.5 psig = 1.4 atm gauge). If a hole develops in the storage vessel below the liquid level, the liquid will be driven out of the hole at a high rate by the high storage pressure in the vessel. Furthermore, since the butane liquid is stored at a temperature above its normal boiling point, a large fraction of the butane liquid will almost instantly flash into vapor as it escapes through the hole. This vapor will then mix with the surrounding air to form a potentially flammable mixture. If the mixture is ignited, an explosion or fireball will result. This type of accident would have considerable impact on the surrounding area.

The second approach (refrigeration case) is to refrigerate the butane to keep the temperature below its normal boiling point. Since the refrigeration – not the pressure - maintains the butane

as a liquid, the butane liquid can be stored in a low pressure vessel. The pressure in this vessel must be maintained at a pressure equal to or above the vapor pressure of the liquid butane at 28°F, which is 0.94 atm absolute. A small amount of nitrogen is probably added to the vapor space of the vessel to maintain the pressure slightly above the outside pressure – for this specific butane case the storage vessel pressure is slightly less than 1 psig. If a hole develops in the tank below the liquid level, the discharge rate of the liquid through the hole will be smaller than the discharge rate for the pressure case due to the lower pressure in the vessel. Furthermore, none of the butane liquid will flash into vapor until its temperature is increased to its boiling point of 31.1°F. The liquid will drop to the ground and form a pool of boiling butane with the boiling rate determined by the heat transfer from the ground. The boiling rate for this pool will initially be high since the ground is warm, but the boiling rate will diminish as the ground is cooled by the colder butane. The rate at which butane vapor is formed in this case will be much less than for the pressure case. Thus, the geometric extent of the vapor cloud will be less. If the vapor were ignited, the explosion would be smaller. A flash fire and subsequent pool fire are more likely.

The advantages to the refrigeration case over the pressure case are: 1) the storage vessel pressure is much lower, resulting in a lower discharge of liquid, and 2) very little of the cold butane liquid will flash into vapor until it reaches the warmer ground and more will remain as liquid in the boiling pool.

The consequences for the refrigeration case are less than the pressure case because the rate at which butane vapor is produced will be less, resulting in a smaller vapor cloud than in the pressure case.

Since the consequences of the refrigeration case are less, so is the risk, assuming the probability stays the same.

The North Gaffey Street facility uses the refrigeration case.

The remote impoundment area also decreases the consequences of an accident and decreases the risk. Any liquid butane that leaks out of the storage vessels or associated piping is drained away from the storage vessels to the impoundment area. This decreases the accident consequences in the following two ways. First, the impoundment area is remote from the storage vessels. Thus, if the impoundment area fills with butane and catches on fire, the storage vessels will not be directly exposed to this fire. This is important since a storage vessel exposed to fire might eventually fail. Second, the impoundment area reduces the surface area of the potential pool decreasing the evaporation rate of the butane.

The North Gaffey Street facility storage vessels are also insulated. This is used to reduce the heat transfer to the butane from the outside of the tanke to reduce the refrigeration load required to keep the butane at 28°F. It also decreases the consequences of an accident by providing addition fire protection in the event of an external fire. The insulation decreases the heat transfer to the butane liquid from the external flames.

The storage vessels are also low pressure storage vessels. This means that a BLEVE – boiling liquid expanding vapor explosion - is not possible. A BLEVE requires a high pressure storage vessel.

Finally, the storage vessels are vertical storage vessels, rather than more traditional spheres. Spheres have the problem that they must be elevated from the ground, providing an exposed surface at the bottom of the sphere. This exposed surface would have high heat transfer from any ground fires during an accident. For a vertical vessel, with the bottom of the vessel on the ground, only the outer lower surface of the vessel is exposed to the fire. The exposed area is less than the exposed area for the sphere. Thus, the total heat transferred from the fire is less for a vertical vessel than for a sphere.

As I stated earlier, the design features I just discussed dramatically reduce the accident consequences and risk. If these features are not included in the QRA, then the consequences of an accident and subsequent risk will be substantially overestimated.

It is clear to me that the Cornerstone Technologies report did not include these design features in their analysis and as a result they overestimated the consequences of an accident scenario and over-predicted the risk.

I will review each of the scenarios from the Cornerstone Technologies report (report 1).

Alternative Release – Vapor Cloud Explosion #1
This assumes a puncture of the vessel. This in itself is not a likely scenario since the vessel is in a protected area. A more realistic scenario is rupture of a pipe connected to the vessel.

The scenario also assumes that all of the liquid escaping will vaporize instantly – a physically impossible situation with refrigerated butane as discussed above.

Alternative Release – Vapor Cloud Explosion #2
The scenario also assumes that all of the vapor escaping will vaporize instantly – a physically impossible situation with refrigerated butane as discussed above.

Alternative Release – Pool Fire #1
In this case the size of the pool is very important to estimate the heat load. The Cornerstone Technologies report does not say anything about the pool size. The size of the pool is limited by the size of the impoundment area. I believe the area of the impoundment area is less than the area of the pool used for the Cornerstone Technologies calculation. Thus, the vaporization rate of the butane is much too high.

Alternative Release – Pool Fire #2
Same issues as Alternative Release – Pool Fire #1

Worst-Case Scenario – Vapor Cloud Explosion #1
This scenario assumes that the entire butane liquid inventory of one tank is instantly vaporized – a phenomenon that is physically impossible. In reality, if this were to occur the liquid would

flow into the impoundment area and a boiling pool would result. The rate of vapor release would be significantly lower than an instantaneous release.

It is also unlikely that the vapor would disperse to a precisely flammable mixture and then ignite at that exact instant.

Worst-Case Scenario – Vapor Cloud Explosion #2
Same issues as Worst Case Scenario – Vapor Cloud Explosion #1.

Alternative Release – BLEVE #1
The definition of a BLEVE used in the Cornerstone Technologies report is not correct. Thus, this case is technically invalid.

Alternative Release – BLEVE #2
Same issue as Alternative Release – BLEVE #1. This is technically invalid.

The Cornerstone Technologies Report used the EPA's RMP*Comp software to estimate the consequences of each scenario. This software is free from EPA and is not appropriate for application to do a QRA. I would never recommend or consider use of this software for this application.

The Quest Consultants Report contains much more realistic scenarios that includes the safety features that I described at the beginning of my report. They used the CANARY computer code to estimate the consequences of the scenarios. I do not have access to this code, nor have I used it. I have heard of CANARY and believe that it is a very credible code for application for these scenarios.

The Quest Consultants report assumed a full-bore rupture of a 14-inch line. This is actually fairly conservative – most risk analysts I know assume that only a fraction of the pipe area contributes to the release – some as low as 20% of the pipe area for this size pipe.

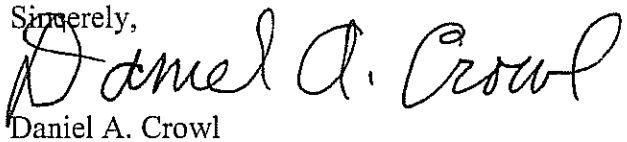
Summary

The Cornerstone Technologies report defines unrealistic scenarios by not including many of the safety design features used in this facility. Many of the scenarios were not physically possible or technically invalid. Furthermore, they used a free computer code that was not designed for this type of analysis.

The Quest Consultants report defines very realistic scenarios which properly includes the safety design features for this facility. They used a much more capable computer code to estimate the consequences. The calculations were completed using technically valid and industry standard approaches.

To the best of my expert opinion, the Quest Consultants report is by far the superior analysis of the consequences of an accident at the Plains LPG North Gaffey Street facility.

Sincerely,



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